Session 6: Evolutionary Path to Mars

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Panel Objectives:

- Discuss ideas for ensuring that the GER mission themes can contribute to eventual human missions to the surface of Mars.
- Share emerging strategies and how these concepts inform requirements for capabilities which can be demonstrated or advanced in the lunar vicinity, including an assessment of strategic knowledge gaps.
- Look at the opportunities provided by implementing a human mission to the Mars system as a precursor to subsequent missions to the surface. The features of what can be gained by such a mission or missions will be discussed.

Session 6: Evolutionary Path to Mars

Emerging Strategies in the Context of a Capability Driven Framework	Bret Drake (NASA)
Ensuring GER Near-Term steps enable future Mars Missions: The Proving Ground	Roland Martinez (NASA)
Summary of the 2013 Affording Mars Workshop	Harley Thronson (NASA), Chris Carberry (Explore Mars)
Status of the ExoMars Programme	Vincenzo Giorgio (Thales Alenia Space)
Panel of Experts: Moderated by Bret Drake	
Human Research Program	Craig Kundrot (NASA)
Transportation	Les Johnson (NASA)
Exploration and Operations	Steve Hoffman (SAIC)
International Space Station Opportunities	Sam Scimemi (NASA)
ExoMars	Vincenzo Giorgio (TASI)
Questions for the Panel	All

Emerging Strategies in the Context of a Capability Driven Framework

Bret G. Drake

NASA Lyndon B. Johnson Space Center

Why Explore?

- A Driver for New Technologies and Capabilities
- Enabling Broad Exploration
- Serves to Motivate
- Making Space Habitable and Accessible
- Search for Life Beyond Earth
- Understanding Earth by Unraveling Mars
- Humans with Robots Working Together

Strategic Principles for Incremental Building of Capabilities

Six key strategic principles to provide a sustainable program:

1. Executable with current ***budget with modest increases***
2. Application of ***high Technology Readiness Level*** (TRL) technologies for near term, while focusing research on technologies to address challenges of future missions
3. ***Near-term mission*** opportunities with a defined cadence of compelling missions providing for an incremental buildup of capabilities for more complex missions over time
4. Opportunities for ***US Commercial Business*** to further enhance the experience and business base learned from the ISS logistics and crew market
5. ***Multi-use*** Space Infrastructure
6. Significant ***International participation***, leveraging current International Space Station partnerships

HUMAN EXPLORATION

NASA's Path to Mars

EARTH RELIANT

MISSION: 6 TO 12 MONTHS
RETURN TO EARTH: HOURS

Mastering fundamentals aboard the International Space Station

U.S. companies provide access to low-Earth orbit

PROVING GROUND

MISSION: 1 TO 12 MONTHS
RETURN TO EARTH: DAYS

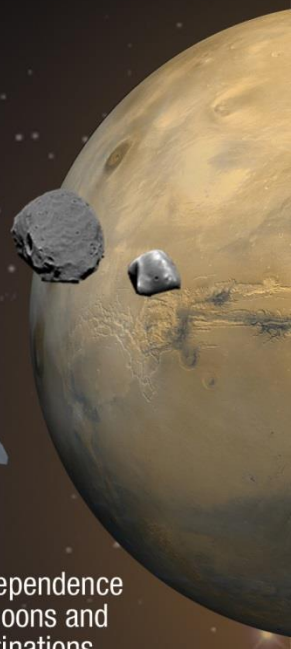
Expanding capabilities by visiting an asteroid redirected to a lunar distant retrograde orbit

The next step: traveling beyond low-Earth orbit with the Space Launch System rocket and Orion spacecraft

MARS READY

MISSION: 2 TO 3 YEARS
RETURN TO EARTH: MONTHS

Developing planetary independence by exploring Mars, its moons and other deep space destinations



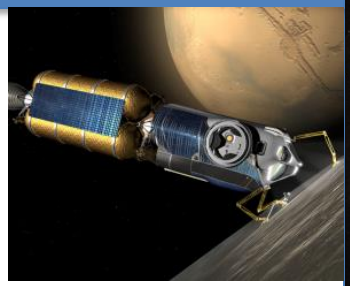
Use the lunar vicinity as a proving ground to demonstrate capabilities and learn to manage the risks of the deep space environment.

The Four Corners of Mars Missions

Mars Orbital Mission

- Potential first mission to the Mars system
- Postpones development of landing and ascent systems
- Demonstrates ability to support humans for long durations in deep space
- Demonstrates advanced propulsion techniques
- Teleoperation of Mars surface assets
- Key challenges: Human health, system reliability, crew autonomy, transportation

Mars Moons – Phobos & Deimos



- Potential first mission to the Mars system
- Exploration of a scientifically rich destination
- Demonstrates ability to support humans for long durations in deep space
- Demonstrates advanced propulsion techniques
- Teleoperation of Mars surface assets
- Key challenges: Human health, system reliability, crew autonomy, transportation, environment

Mars Short Surface Stay Mission

- Potential first human mission to the surface of Mars
- Range of exploration limited by capabilities and duration of time on surface
- Long duration mission with short stay to minimize total mission mass
- Key challenges: Human health, system reliability, crew autonomy, transportation, environment, landing and ascent

Mars Long Surface Stay Mission

- First long-stay on the surface of Mars
- More benign mission mode for human health
- Maximizes exploration return and collaboration
- Long duration mission with long-stay on Mars
- Key challenges: Human health, system reliability, crew autonomy, transportation, environment, landing and ascent, use of local resources, power, surface systems

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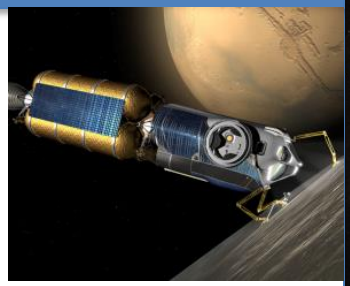

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Evolutionary Path to Mars

	Mission / Sequence	Current ISS Mission	Cis-Lunar /Asteroid Redirect Mission	Long Stay In Deep Space	Mars Orbit	Mars Surface, Short Stay	Mars Surface, Long Stay
Mars Destination Capabilities	In Situ Resource Utilization & Surface Power						X
	Surface Habitat						X
	Entry Descent Landing, Human Lander					X	X
	Advanced Cryogenic Upper Stage				X	X	X
Initial Exploration Capabilities	Deep Space Habitat		X	X	X	X	X
	Solar Electric Propulsion for Cargo		X	X	X	X	X
	Exploration EVA		X	X	X	X	X
	Crew Operations beyond LEO (Orion)		X	X	X	X	X
	Deep Space Guidance Navigation and Control/Automated Rendezvous		X	X	X	X	X
	Crew Return from Beyond LEO – High Speed Entry (Orion)		X	X	X	X	X
	Heavy Lift Beyond LEO (SLS)		X	X	X	X	X
ISS Derived Capabilities	Deep Space Habitat Systems Tests	*	→	X	X	X	X
	High Reliability Life Support	*	→	X	X	X	X
	Autonomous Assembly	*	→	X	X	X	X